INTEGRATION OF COMMUNICATION MEANS FOR HOME CARE IN CHRONIC DISEASE MANAGEMENT

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Abstract-**Health care delivery is changing drastically. In its current state it tends to use the home care model in order to improve quality of life, to rationalize costs and to achieve wellness. Pivotal to these purposes are contact centers, which act as mediators between the medical staff and the citizens seeking advice and/or treatment. Main platforms used for the development of such applications are the Internet and computers, and the telecommunication networks, including mobile solutions. In this paper, an integrated platform is proposed, offering the patient multiple means of communication with the contact center, along with personalization of the services provided.**

Keywords **- Home Care, Telemedicine, WAP, Contact Center**

I. INTRODUCTION

The goal of this paper is to present the structure of a generic contact center, identical to the one proposed in the IST project "Distance Information Technologies for Home Care. The Citizen Health System (CHS)", and to present an implementation on interactive exchange of messages and data through multiple communication interfaces such as mobile WAP phone, Internet and automated call center technology.

In the past, telemedicine was basically considered a supplementary means of medical practice, as seen in the case of an emergency when there is no other way than substituting with telemedicine, since it is not possible for a doctor to see a patient directly. Recently, however, with the growth of telecommunications and information technology, the way of thinking towards telemedicine has been changing.

A number of studies verify that healthcare informatics are essential in preventive medicine [1]. These reports also stress the significance of home care delivery as an important alternative. On the other hand there is evidence that distance information technology has more solutions available today, and that consultation, education, and data exchange sessions can take place over the telephone network and over the Internet as well [2-5].

In telecare applications, the role of the patient becomes central, since the patient is actively involved in the process of managing care and treatment, and since patient and family are responsible for collecting some measurements and related information. The management of a chronic patient is therefore a collective and cooperative activity that may take advantage of Information Technology to improve the overall quality of care.

Initial evidence in chronic disease groups has shown that patient-computer interaction appears to be a valuable supplement to interaction with clinicians. Considering the need to enhance patient participation in the care of chronic illnesses, initial evidence indicates that computers can play a more significant role in the future [6]. Overall, electronic monitoring at home promises cost effective health services, more active involvement of patients in their own care, and a new sense of realism in making a diagnosis. Home distance monitoring often requires the creative use of not just various measurements or monitoring devices but also communication technologies and organizational support services.

However, it seems that there is a variation among these patients, concerning their familiarity with new technologies, depending on their age and other factors. A universal platform was designed, which is able to incorporate different means of communication implementing the same scenario of patient interaction, adapted to the patient's personal communication choice.

II. METHODS

A. CHS Objectives

The overall objective of this project is the use of Information Technology for the increased quality of health care. The involvement of every single home and every single health care level is the ultimate objective. In particular, the objectives of the project can be divided into three major categories:

Information technology related objectives

- Development of new generation telemedicine services for home care.
- Integration techniques for developing a complete health system for home care addressing issues such as integration of telematics technologies, data acquisition devices, educational material through the WWW, data security and data fusion.

Quality of health care objectives

- Cost effectiveness of health care delivery via the use of the home health care system, which would permit the avoidance of unnecessary patient visits to the hospital.
- Citizen involvement in health care delivery by use of recording micro-devices, and by the continuing education process delivered through the health system to be developed in this project.
- Better diagnosis opportunities for the clinical staff through the increased sampling frequency of vital parameters and signals from the patients through the home care system platform.

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Abstract

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Economic and business objectives

- The creation of a major market for health care delivery, analogous to that of the INTERNET market, through penetration to European and US homes through applications of the home health care system.

B. System Requirements

A substantial requirements set for the home-care system is that patient interfaces should be kept as simple and user friendly as possible. The system has to be customisable and each patient's profile should designate the kind of information delivered to/from the patient. Besides, the system has to be open and flexible offering the patients a number of technologies to choose from, in order to communicate, according to their life style and adaptation to technology.

Although most of the functionality has to be automated, direct interaction with nurse should not be completely eliminated (especially for medical advice).

Information, especially for educational purposes, should be presented with friendly, easily understandable and accessible interfaces, avoiding too much information in printed material. Besides, information should be presented in the user's preferred language.

From a development point of view it is crucial that such a system should be modular and provide integration of different communication means and modules of independent functionality, like the artifact rejection module and the customisation module. Basic modules in each new interface should be re-usable and the overall application should be expandable to new technologies. Finally, system security is crucial since the system deals with sensitive personal data.

C. Implementation

For the Contact Center Unit, where the database information includes complicated relationships between several tables and the number of clients grows, a multi-tiered application is preferable. In multi-tiered database applications, an application is partitioned into pieces that reside on different machines. A client application provides a user interface to access data. It passes all data requests and updates through an application server. The application server, in turn, communicates directly with a remote database server. Multi-tiered applications include middle tiers that centralize the logic that governs the database interactions, so that there is centralized control over data relationships. This allows different client applications to use the same data, while ensuring that the data logic is consistent. They also allow for smaller client applications because much of the processing is off-loaded onto middle tiers. Multi-tiered applications can also improve performance by spreading the data-processing tasks over several systems.

The communication over the network between the home-care and clinic-center units is the most important part of the Citizen Health System. The server located at the contact center should be able to concurrently communicate with multiple home-clients, to support security and to provide data integrity.

Three different technologies have been chosen for the patient interfaces, so that patients may choose the communication means of their preference:

1) Computer Telephony: Fully automatic telephone Contact Center
2) Wireless Technology : WAP
3) Internet

Each of the communication means has different characteristics, although they all ensure 2-way communication, e.g. user interaction in a simple manner. The cheapest technology with the widest penetration is the use of regular telephone with call-center automation. Web interface is user-friendly but the required infrastructure is not available in every house. Besides, among elderly people, who might be an important target group for chronic disease home-care management, computer literacy is not granted. WAP is an emerging technology which is popular among certain population categories.

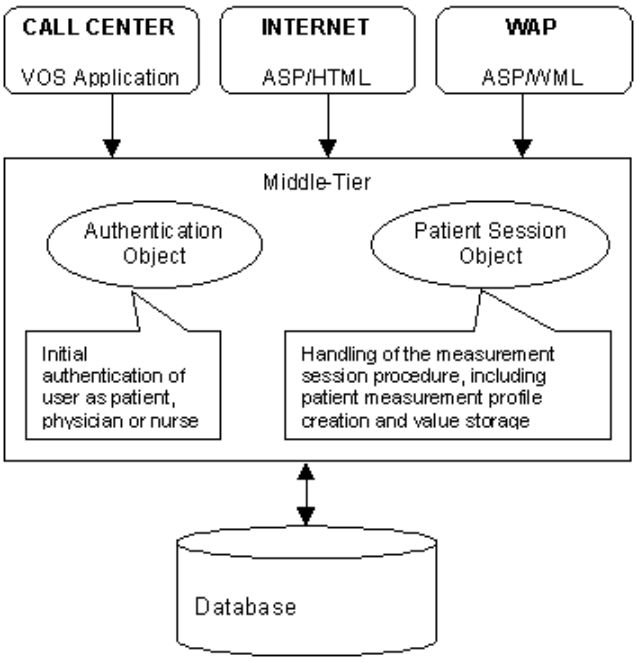

Fig. 1. The overall structure of the generic contact center of the CHS project

In order to integrate different interfaces (communication means), an intermediate is required between client interface and database. Thus, a client/server (3-tier) architecture has been selected (Fig. 1). The middle-tier include objects that are compiled software components based on Microsoft's Component Object Model (COM) technology and they are basically modular programs designed to give specific functionality to a parent application. COM is a language independent software component model designed by

Microsoft to enable interaction between software components and applications. The key feature of COM is that it enables communication between components, between applications, and between clients and servers through clearly defined interfaces.

The advantages of such an implementation are:

- Encapsulation of business logic in a shared middle-tier.
- Different client applications all access the same middle-tier, avoiding the redundancy of duplicating business rules for each one.
- Client applications can delegate more of the processing to middle-tiers.
- No need for installing/configuring the database connectivity software for client applications.

Computer Telephony functionality was implemented as an automated call center which is programmable and controlled by a personal computer via a Dialogic card. Parity VOS development platform was used. This platform embeds the functionality of scheduling, outbound calls and reminders.

In order to provide dynamic characteristics to the Web/WAP content, the technology of Active Server Pages (ASP) was adopted. ASP is a server-side scripting technology that can be used to create dynamic and interactive Web applications. An ASP page is typically an HTML page that contains server-side scripts that are processed by the Web server before being sent to the user's browser.

ASP can be combined with HTML, Extensible Markup Language (XML) and Component Object Model (COM) to create powerful interactive Web sites and extend scripting capabilities. It is interesting that the same COM components can be used in both Web and WAP interfaces.

In our case, the Active Server Pages that contain the HTML/WML content are hosted in the Microsoft Internet Information Server (IIS), which is a widespread Web server system integrated with Windows NT Server. IIS makes it easy to publish information and bring applications to the Web.

A WAP Gateway is also needed, in order to provide the connection between the wireless environment and the Internet. Its basic role is to convert protocols of the wireless domain to the corresponding Internet protocols and vice versa. Furthermore, it encodes content in a specific binary format and provides security mechanisms, guaranteeing a secure communication environment. The gateway resides in the wireless network provider's infrastructure and is available to the mobile phone users.

Special attention was paid during system database design, in order to ensure the possibility of customization, such as personal monitoring profile definition for each patient, which will dynamically generate each patient's interface and information presentation.

User authentication is a separate module used in all interfaces for security reasons. It is also important that direct database access is prevented since all database interactions are hidden by the middle-tier.

D. The application scenario for a patient

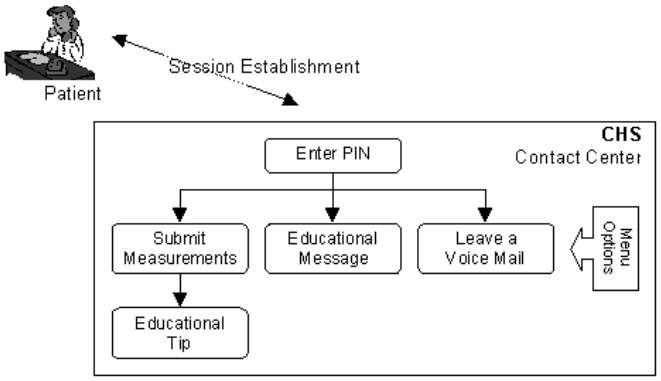

Fig. 2. The patient session using the automatic call center

The services provided via the home care system are:

- Measurements. Each patient may send measurements like blood pressure, glucose, pulse or weight. These measurements are taken at home using simple devices (like a home glucometer). Complementary to the measurements are a number of questions asked to the patients, since the corresponding answers may be explanatory of their condition. The values are keyed in using the selected technology (WAP, WEB or regular phone). The set of required values and questions may be personalised for each patient. Vital signs like ECG may also be transmitted to the system by use of transtelephonic devices.

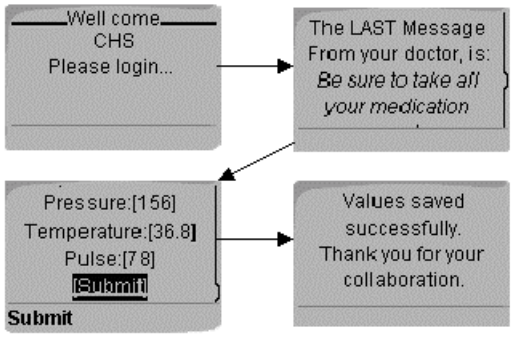

Fig. 3. Screen sequences for a patient session using WAP, with the following units: (a) login and authentication, (b) read possible messages from physician, (c) enter measured values and answer questions, (d) save values.

- Education. Each patient can attend educational sessions, either on demand, when he/she needs some information on a specific subject, or scheduled ones where the system calls automatically the patient for more detailed educational sessions on subjects that are of importance. All educational messages are also available in text form, so Internet can be used alternatively for educational purposes. Besides, a pool of Websites with useful information for disease management is available as a reference library.

- Communication with the physician. Depending on the communication media, written or voice messages can be exchanged between patient and physician.

E. Multilinguality Issue

In a customized/personalized system multilinguality is an important issue, concerning both knowledge presentation and interface. The main issues taken into account to ensure control of language used for information presentation are:

- Keeping information in a structured way that is controlled, e.g. in a database.
- Developing configurable systems, (set language as a parameter). Along these main axes, some initial actions were taken towards multilinguality.

Written educational tips/messages were stored in a database in order to be easily translated. An alternative could be to include translated versions of texts in different languages (in case there is a need for multiple languages in a single context). Voice educational messages were also maintained in a structured form, so that they are easily controlled and translated.

III. Results

According to the scenario presented above, the patient can send data from virtually everywhere, provided he/she has the portable devices necessary for the measurements of basic parameters such as arterial blood pressure, blood glucose etc. These recording devices are getting smaller and smaller, and many of them are supporting transtelephonic transmission, which may decrease the session duration, and reduce the number of errors due to wrong data entries. This technology together with prompting physicians can increase the effectiveness in preventive care in the future [7-8].

Home Care is facilitated since multiple means of communication are offered, thus different patient groups are not excluded. This increases patients' involvement in their own health, and hopefully reduces the need for hospitalization.

From a technical point of view, the proposed system is a new idea offering multiple platforms and customization according to user's needs and thus contributes to customization of health care delivery (personal profile). The system is flexible, allowing incorporation of new communication technologies, for example interactive TV, with little development effort, thus, serving the idea of an integrated system for health care delivery.

IV. Conclusion

The proposed work considers a distance monitoring which extends beyond data collection by generating feedback and supporting patient education. It combines initial screening, measurement devices, patient education, decision support, appropriate telephone/WAP/WEB contacts and physician access.

This system will be tested in two clinical trials for the management of diabetes and cardiac heart failure. The evaluation of these trials will help assess user acceptance of the system and clinical effectiveness to monitor patient's state and fine-tune personal patient profiles.

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